Syllabus – Microelectronics Manufacturing and the Environment

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Department of Chemical & Environmental Engineering

CHEE, MSE & ECE 415 & 515

Course Description

- **This course will focus on the presentation of basic semiconductor fabrication unit operations as they relate to:**
  - **Theory of operation**
  - **Materials**
  - **Equipment**
  - **Fabrication processes**
  - **Key environmental impacts and challenges**
- **Prerequisites:**
  - **None**

Instructor Information

- **Instructor:**
  - **Name:** **Ara Philipossian**
  - **Office:** **Electrical & Computer Engineering Building, Room 223**
  - **Phone:** **520 621 6101**
  - **E-Mail:** **ara@engr.arizona.edu**

- **Office Hours:**
  - **TBD**
  - **There will be no TA for this course**
  - **Other times by appointment only (send me an e-mail please)**
  - **Office hours are subject to change**

Method of Instruction

- **Class location: TBD – Class meets once a week for 2½ hours with an additional 10 minute break in between.**

- **Course will be delivered in the form of traditional lectures as well as instructional videos:**

– Prof. Ara Philipossian	UA – Lectures
– Prof. Farhang Shadman	UA – Video
– Dr. Michael Goldstein	Intel – Video
– Prof. Srini Raghavan	UA – Video
– Dr. Robert Meagley	Intel – Video
– Dr. Larry Larsen	Sematech – Video

- **<u>Self-discipline will be paramount</u> in order to keep up with the pace and the volume (and format) of information delivered.**

Method of Instruction (continued)

- **Homework:**
  - **Twenty or so assignments**
- **Exams:**
  - **Mid-Term No. 1**
  - **Mid-Term No. 2**
- **Group Project Proposal (Written and Oral):**
  - **Please see the next 5 slides**

Project Proposal

- **ORAL PRESENTATION AND SUBMISSION DEADLINE**
  - **Due date: TBD**
  - **Deliver a hardcopy to Ara Philipossian in the class**
  - **Present to the entire class (no more than 10 minutes and 9 PPT slides)**
- **WRITTEN PROPOSAL LENGTH**
  - **No more than 14 pages including figures and list of references**
  - **Keep it crisp and to the point**
  - **Font size: 11**
  - **Spacing: Double**
- **MAXIMUM OF 5 STUDENTS PER GROUP**

Project Proposal (continued)

- **FOCUS AREAS**
  - **Process consumables replacement**
  - **Process consumables reduction**
  - **Process consumables re-use**
- **TOPICS TO CHOSE FROM**
  - **Electroplating of copper**
  - **CMP of copper or dielectrics**
  - **CMP of Shallow Trench Isolation**
  - **Thermal oxidation**
  - **LPCVD of dielectrics**
  - **LPCVD of tungsten**
  - **Wet cleaning and surface preparation**
  - **Dry cleaning & surface preparation**
  - **Rinsing**
  - **Drying**
  - **Post-CMP cleaning**

Project Proposal (continued)

- **TOPICS TO CHOSE FROM (CONTINUED)**
  - Wet etching of silicon nitride or silicon dioxide
  - Dry etching of silicon dioxide
  - PVD of copper
  - Plasma etching
  - Lithography

- **RESEARCH OBJECTIVE**
  - What problem are you solving?
  - What opportunities are you suggesting to be exploited?
  - What technology or usage issues motivate this problem?
  - What has been done in this area in the past?
  - How does your proposed work differ from what's already been done by other researchers?
  - What is your research hypothesis?
  - How will you verify that hypothesis?
  - What is the potential impact on industry practice if the hypothesis is verified?

Project Proposal (continued)

- **RELATIONSHIP TO OTHER RESEARCH OR PRATICE**
  - What similar research to this proposal is being conducted by other universities?
  - How does this proposal differ from that research
- **RESEARCH POTENTIAL IMPACT**
  - What concrete results are expected?
  - How could those results be put into practice?
  - How could an IC manufacturer benefit from the completion of this work?
  - What technological advances must happen for that benefit to be realized?
- **RESEARCH PLAN (ASSUME A 2-YEAR DURATION)**
  - Deliverables
  - Timeline
  - Technical tradeoffs that may have to be made
  - Risks in this research and how they will be managed

Project Proposal (continued)

- **BIBLIOGRAPHY**
  - **Roughly 10 publications relating to state-of-the-art and your proposed work**
  - **Attach hardcopies of all referenced publications and submit it with your report (note that these pages are in addition to the 14 pages containing your report)**
- **GRADING**
  - **Your grade will be based on the following:**
    - **Creativity**
    - **Originality**
    - **Aesthetics & professionalism of the report**
    - **Impact to industry**
    - **Completeness & relevance of previous work cited in the bibliography and your ability to structure your proposal recognizing what's been done before by other researchers**
    - **Likelihood of success of your proposal**

YOUR Final Grade

- **Homework** — **ZERO – I will not be collecting or grading any of the HWs**
  I will post all solutions on D2L
  Exams will be based on HW
- **Mid-Term Exam 1** — **30%**
- **Mid-Term Exam 2** — **40%**
- **Proposal** — **30%**

Books

- **Required Textbook:**
  - **Microchip Manufacturing by S. Wolf, Lattice Press (2004).**
- **Recommended Books:**
  - **Microchip Fabrication: A Practical Guide to Semiconductor Processing, 4th Edition, by Peter Van Zant, McGraw-Hill Publishers (2000).**
  - **VLSI Fabrication Principles: Silicon and Gallium Arsenide, by Sorab K. Ghandhi, John Wiley (1994)**
  - **Handbook of Semiconductor Wafer Cleaning Technology, by Werner Kern, Noyes Publications (1993)**
  - **Chemical Mechanical Planarization of Microelectronic Materials, by Steigerwald, Murarka & Gutmann, John Wiley & Sons (1997).**
  - **Process Engineering Analysis in Semiconductor Device Fabrication, by Middleman and Hochberg, McGraw-Hill Publishers (1993).**

Groundrules

- **There will be no make-up exams whatsoever**
- **Turn off all mobile devices in the classroom**
- **Lectures start promptly**
  - **Please be on time**
  - **Students arriving more than 5 minutes late are requested to wait outside the classroom. Late students will be admitted into the classroom when there is a natural break in the lecture.**
  - **Being 5 minutes late means:**
    - **(5 minutes) x (29 students + 1 instructor)**
    - **2½ hours of other people's time wasted**
  - **If you miss a lecture, please do not ask me for a tutorial on the subjects covered during the lecture**
- **Complete your reading assignment prior to each lecture**

Groundrules (continued)

- **Please do not seek the instructors' help in solving homework problems if you have not given the problem your best shot.**

- **You need to kindly show the instructor in writing your logic and deductive reasoning in attempting to solve a problem before the instructor proceeds to help you**

Course Structure – Subject to Change

- **Lecture No. 1 by Ara Philipossian**
  - **Review of the Syllabus**
  - **Introduction to Device Fabrication**
  - **Introduction to Design for the Environment**
  - **Silicon Wafer Manufacturing – Part 1**
  - **Silicon Wafer Manufacturing – Part 2 (Please watch the video on D2L ASAP)**

- **Lecture No. 2 by Ara Philipossian**
  - **Impurity Diffusion**
  - **Thermal Oxidation**

Course Structure

- **Lecture No. 3 by Ara Philipossian**
  - **Thermal oxidation (continued)**
  - **Dielectric Deposition**
- **Lecture No. 4 by Ara Philipossian, Srini Raghavan and Larry Larsen**
  - **Low k Dielectrics**
  - **Ion Implantation (by Larry Larson – Please watch the video on D2L ASAP)**
  - **You need to download SRIM in order to solve the Implantation HW problems.**
- **Review Lectures (Nos. 5 and 6) by Ara Philipossian**

Mid-Term Exam 1 … Date TBD (duration = 2½ hours)

Course Structure

- **Lecture No. 7 by Ara Philipossian**
  - **Wet Etching, Cleaning and Surface Preparation**
  - **Drying (by Srini Raghavan – Please watch video on D2L ASAP)**

- **Lectures No. 8 and 9 by Ara Philipossian**
  - **Chemical Mechanical Planarization (Parts I and II)**

- **Lecture No. 10 by Ara Philipossian, Farhang Shadman, Michael Goldstein and Robert Meagley – Watch litho and metallization videos on D2L.**
  - **Lecture on the elements of the final proposal plus Q & A**
  - **Ultra-Pure Water Production, Use and Re-Use**
  - **Rinsing**
  - **Photolithography**
  - **Metallization**

Course Structure

- **Review Lecture (No. 11) by Ara Philipossian**
- **Proposal Presentations (written proposal due today in class)!**

Mid-Term Exam 2 … Date TBD (duration = 2½ hours)